Detector Computing

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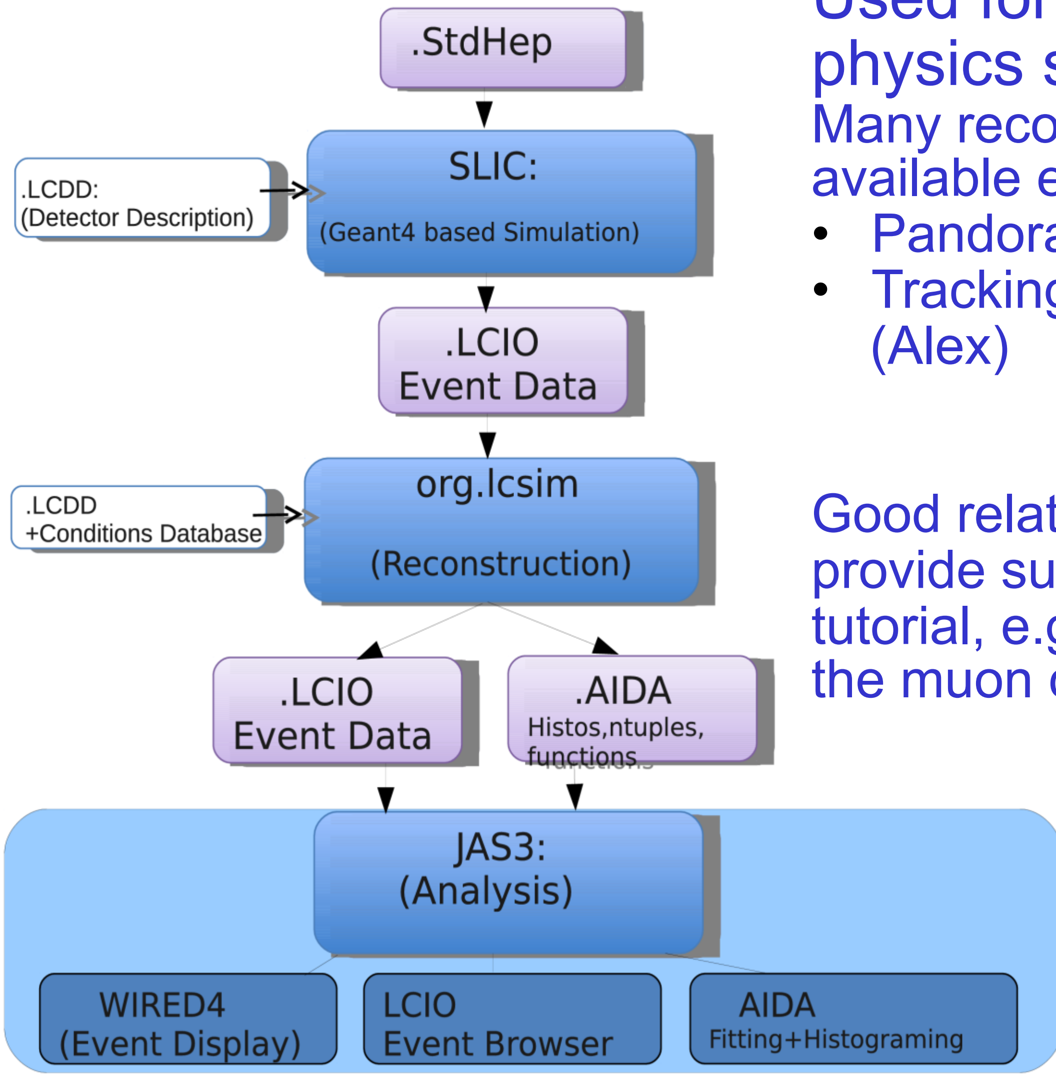
MAP13

June 21st , 2013

U.S. DEPARTMENT OF ENERGY

Fermilab

Software framework



Used for ILC and CLIC physics studies:

Many reconstruction modules available e.g.

- PandoraPFA (Mary Ann)
- Tracking, Vertexing, B-tagging (Alex)

Good relations with SLAC group provide support, contribute to the tutorial, e.g. changes specific to the muon collider

MCDRD (Muon Collider Detector R&D): computing resources

- Virtual Organization (VO): mcdrd
  - Sign up at: https://voms.fnal.gov:8443/voms/mcdrd
  - (we have 250 dedicated slots + opportunistic on fermigrid and we are part of OSG)
  - Resources at NERSC (thanks to Robert D Ryne)
- reference machine on the fermicloud: mcdrd.fnal.gov
  - To get an account contact service desk and request a fermicloud account and request access to mcdrd.
- 1 TB of dedicated disk space on bluearc: /grid/data/mcdrd
  - software installed in: /grid/data/mcdrd/sw
  - detectors jas-assembly-0.9.9 jdk1.7.0_21 mac slic
  - data available in: /grid/data/mcdrd/data

MCDRD: computing resources (cont.)

- 100TB in fermilab mass storage system (dcache, enstore)

  /pnfs/mcdrd/Higgsfactory/
- --> software(dccp) installed on mcdrd to move data in and out of mass storage
- Right now resources are limited but we can probably ask for more when we need it (easier to extend than start from scratch)
- Many thanks to the FermiGrid team!!!!!

Muon Collider Documentation

Created Confluence page:

https://confluence.slac.stanford.edu/display/MCPDS/Home

Look for:

Documentation for Accessing MCD R&D Computing Resources.

Tutorial:

https://confluence.slac.stanford.edu/display/ilc/Installing+lcsim+software+for+the+Winter+2012+tutorial

You can sign up here:

https://jira.slac.stanford.edu/signup/

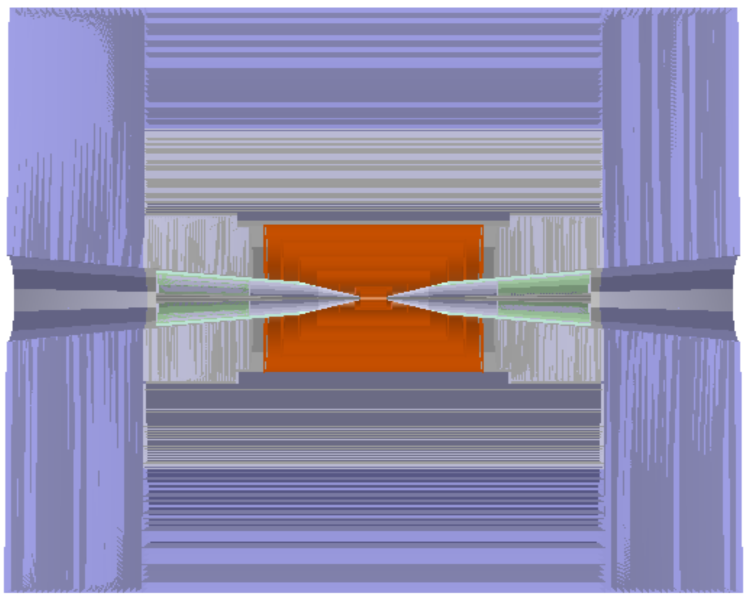
Changes to slic and Geomconverter

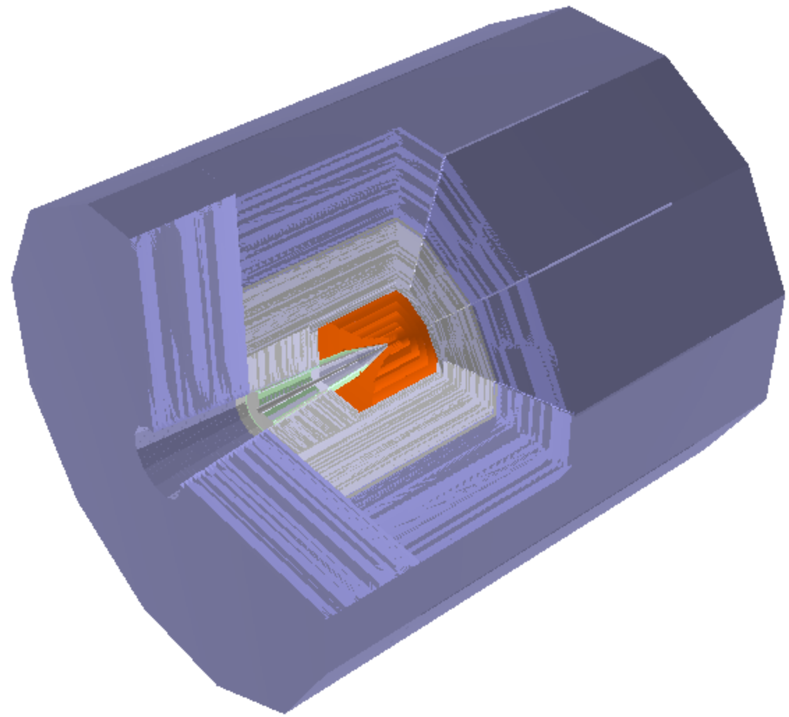
- Slic now uses version of geant 4 (4.9.6.p01) and new build system (cmake).
- Now optical properties can be specified in compact.xml and propagate to .lcdd and .gdml files.
- Optical dual readout (scint. And Cerenkov) calorimeter now available.
- Now we have the chance to kill particles entering a specific volume (e.g. the tungsten cone)

The mcdrcal01 detector in org.lcsim

5T solenoidal field, radius=3.075m

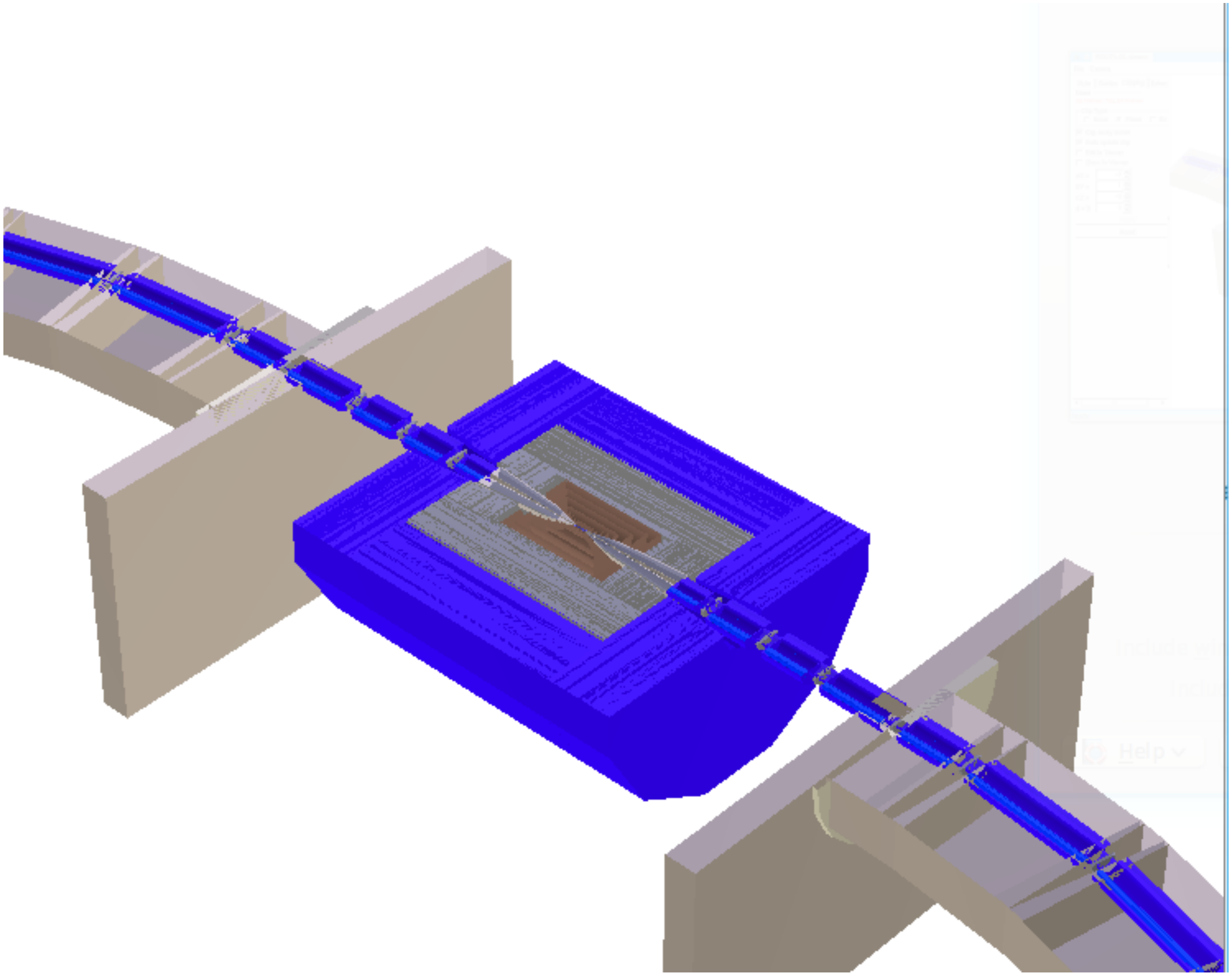
Calorimeter dimensions:
Rmin: 1.36 m
Rmax: 3.07 m
Length: 2x3.702 m





Good relation with accelerator group,
Easy to change detector design if e.g. shielding/MDI changes. Declared DMZ.

HF IR MARS15 Model: 3D View



Motivation for calorimeter choice

- Precise:
  - total absorption (no sampling fluctuations),
  - dual readout correction,
  - Homogeneous;(no difference in ECAL and HCAL response) → results in excellent energy resolution and linearity.
- Fast:
  - Cerenkov light is prompt, new photon detectors like SiPM show excellent timing capabilities → provides handle to get muon decay backgrounds under control.
- Finely granulated:
  - Improve reconstruction even further with PFA algorithms.

Calorimeter Properties for Barrel and Endcaps

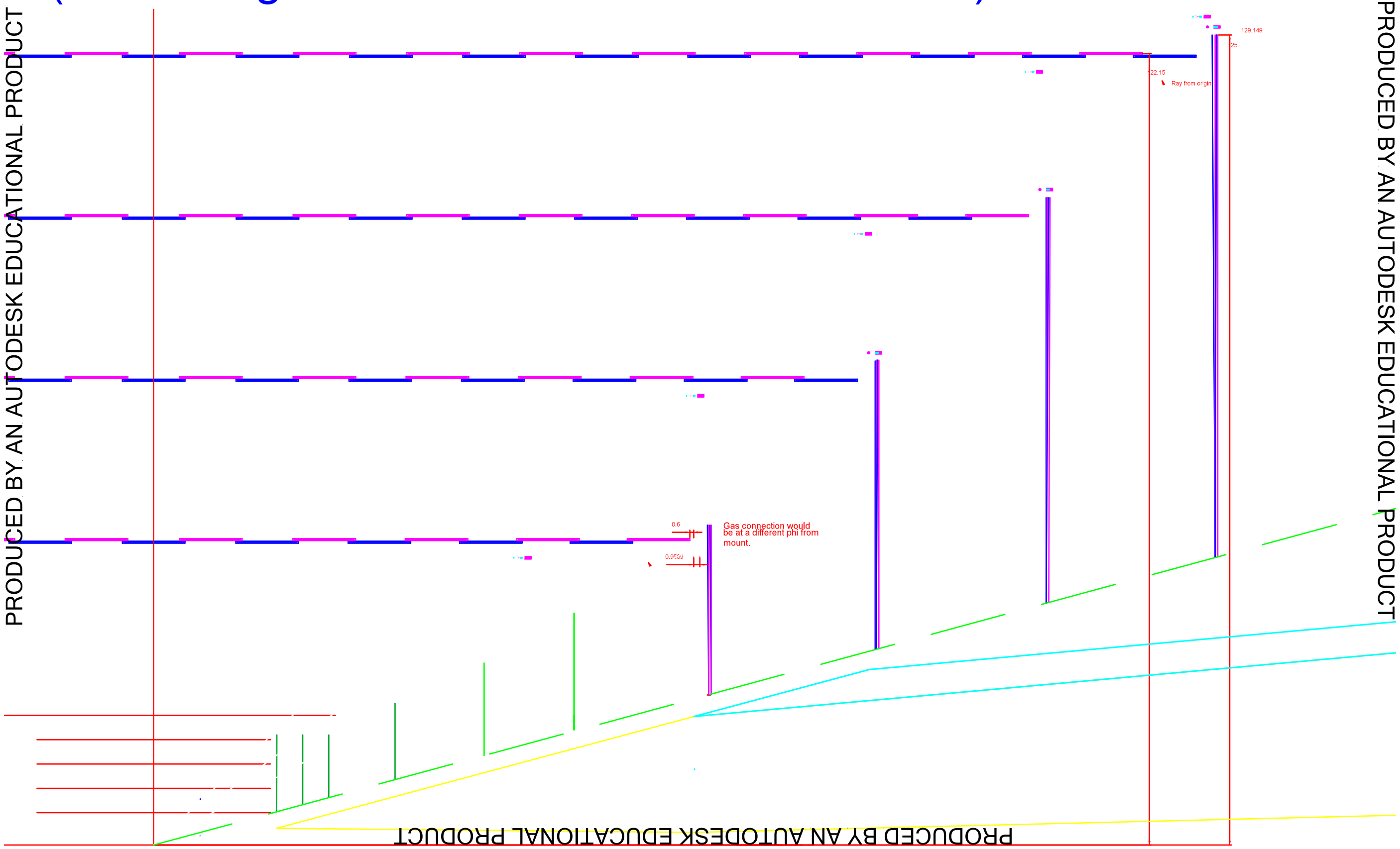
	EM	Hadron	Muon
Material	BGO/PbF_2/$PbWO_4$	BGO/PbF_2/$PbWO_4$	Iron
Density [g/cm^3]	7.13/7.77/8.29	7.13/7.77/8.29	7.85
Cell size [cm^3]	1x1x2	2x2x5	10x10x10
Layers	10	30	22
Detector Depth [cm]	20	150	220
Radiation Length [cm]	1.1/0.93/0.89	1.1/0.93/0.89	1.76
Nuclear Interaction Length [cm]	22.7/22.4/20.7	22.7/22.4/20.7	16.8
Total Nr of IA length (em +had)	**7.5 /7.6/8.2**		

Motivation for tracker choice

- Precise:
  - To achieve the tracking goals while keeping the tracker compact we require a high solenoidal magnetic field of 5 Tesla and use silicon tracking paired with a pixel vertex detector for high precision low mass tracking.
  - Fast timing and fast readout requires extra power and cooling and R&D will be necessary to achieve this while keeping detectors and support at the required low mass. (more CMS than ILC like)

Mcdrcal01: Tracker

Simplified geometry: cylinders and disk no segmentation
(virtual segmentation used in reconstruction)



Mcdrcal01: Tracker Parameters

Vertex Detector barrel

Layer	Pitch rphi	pitch z	sensor thickness	low Z	High Z	Radius
1	20	20	75	-20	20	5.40
2	20	20	75	-20	20	9.45
3	20	20	75	-20	20	13.49
4	20	20	75	-20	20	17.55
5	20	20	75	-30	30	21.59

Vertex Detector Disks

Layer	Pitch rphi	pitch ra	sensor thicknes:	Z	er radius ·	Radius
1	50	50	100	20.5	5.5	18.35
2	50	50	100	24.8	6.7	18.35
3	50	50	100	29.15	7.9	18.35
4	50	50	100	40	10.9	23.6
5	50	50	100	55	14.1	30.32
6	50	50	100	70	19.2	38.6

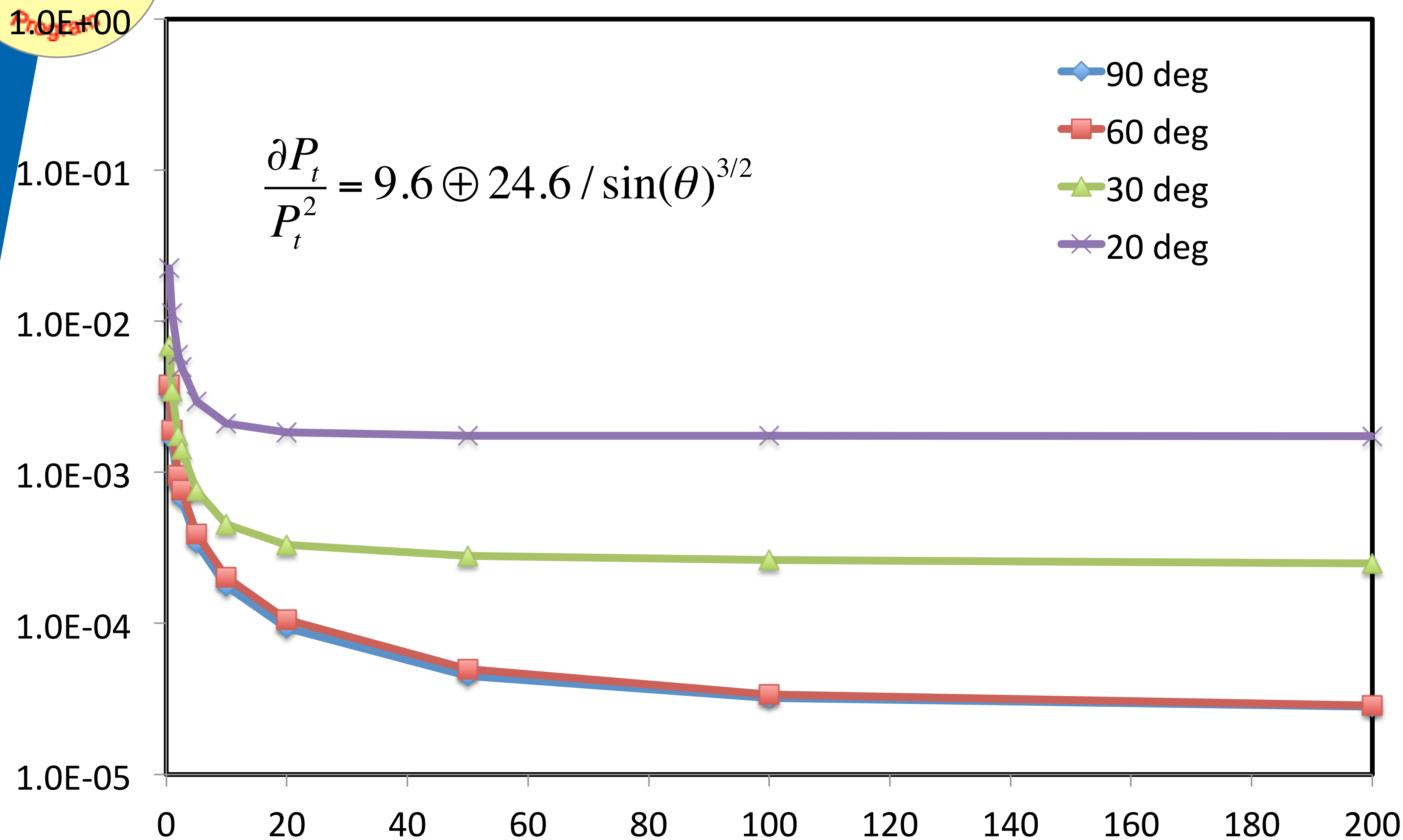
Tracker Barrel

Layer	Pitch rphi	pitch z	sensor thicknes:	low Z	High Z	Radius
1	100	1000	200	-91	91	50
2	100	1000	200	-119	119	77
3	100	1000	200	-147	147	103
4	100	1000	200	-175	175	130

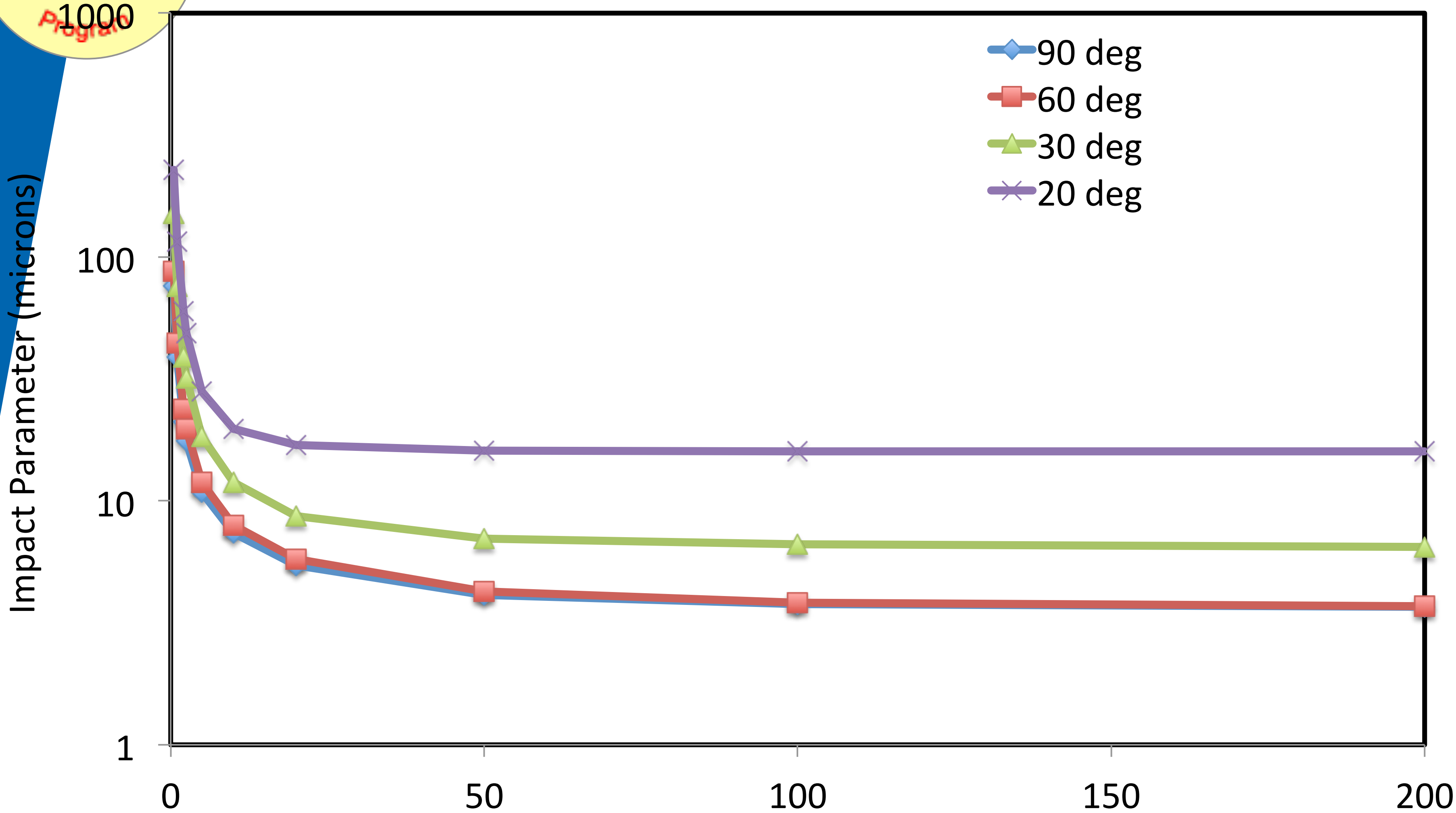
Tracker Disks

Layer	Pitch rphi	pitch ra	sensor thicknes:	Z	er radius ·	Radius
1	100	1000	200	92	25.2	53.3
2	100	1000	200	120.75	32.7	80.8
3	100	1000	200	149	40.4	108
4	100	1000	200	177	48	135

Predicted momentum resolution



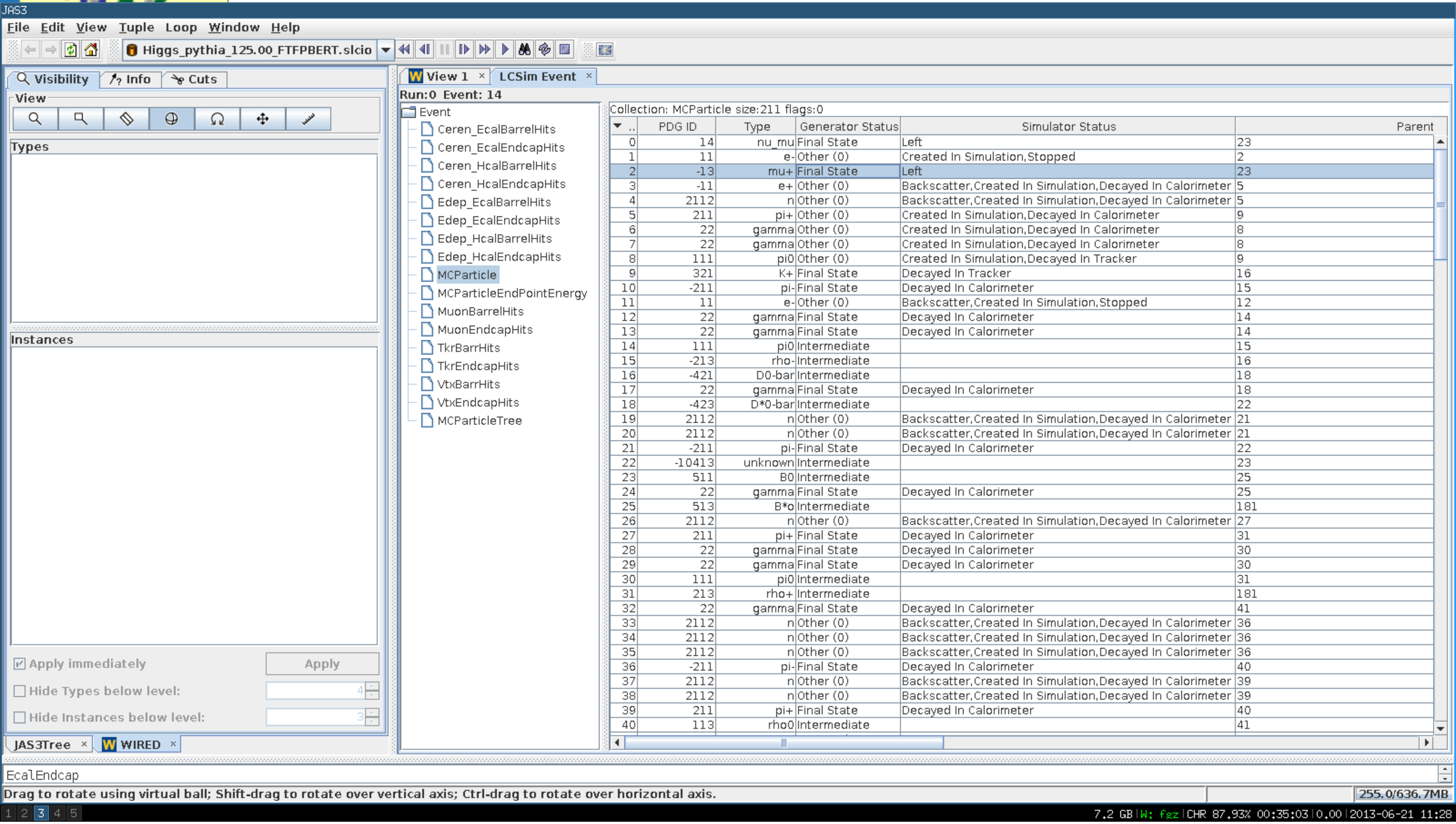
Predicted: Impact Parameter resolution



Caveats

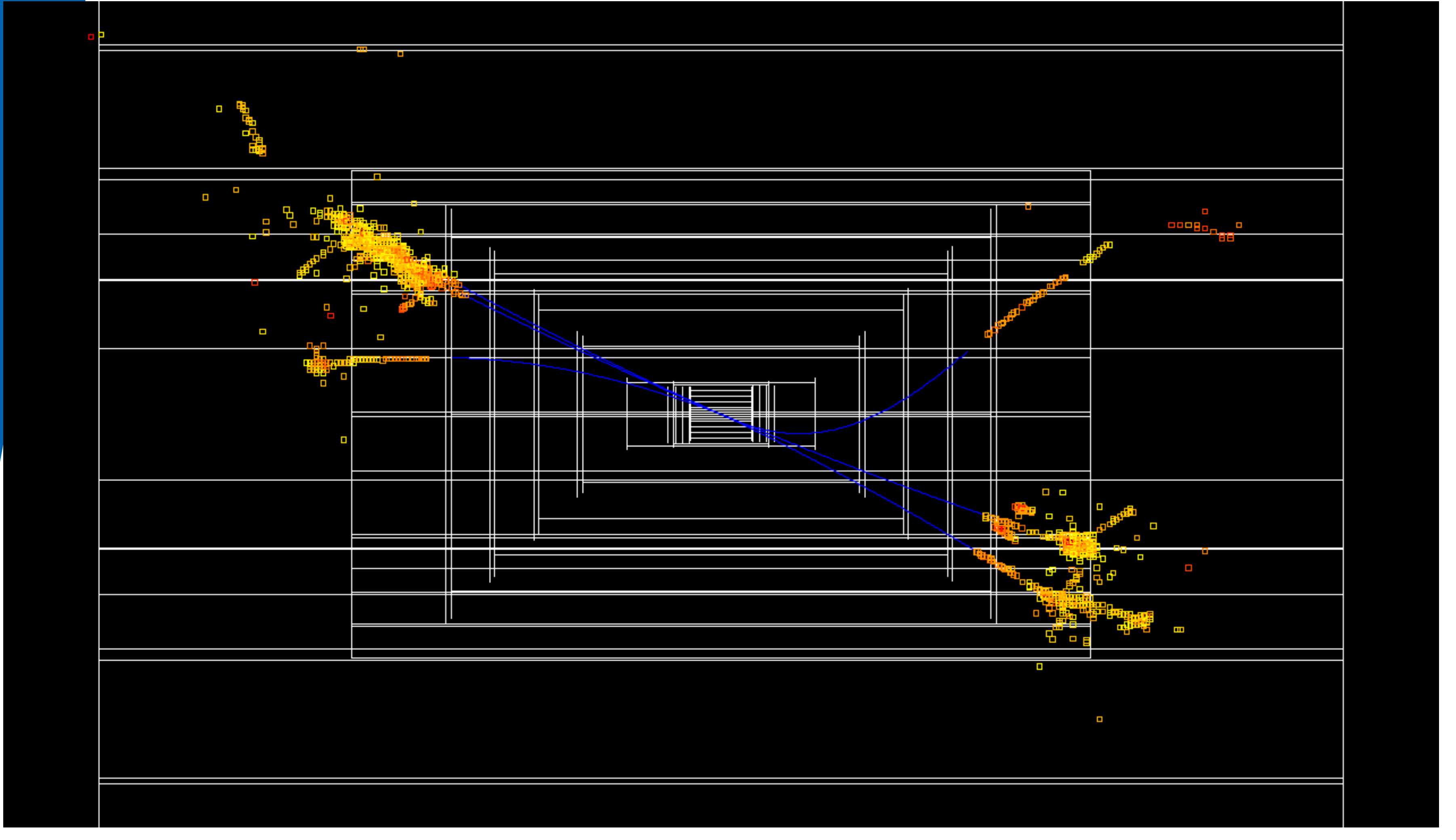
- New detector description still needs to be copied to .lcsim/cache by hand!
- No Material for coil included
- Not enough iron to return flux of 5T solenoidal field
- But list gets smaller!!

JAS3 – Event Browser

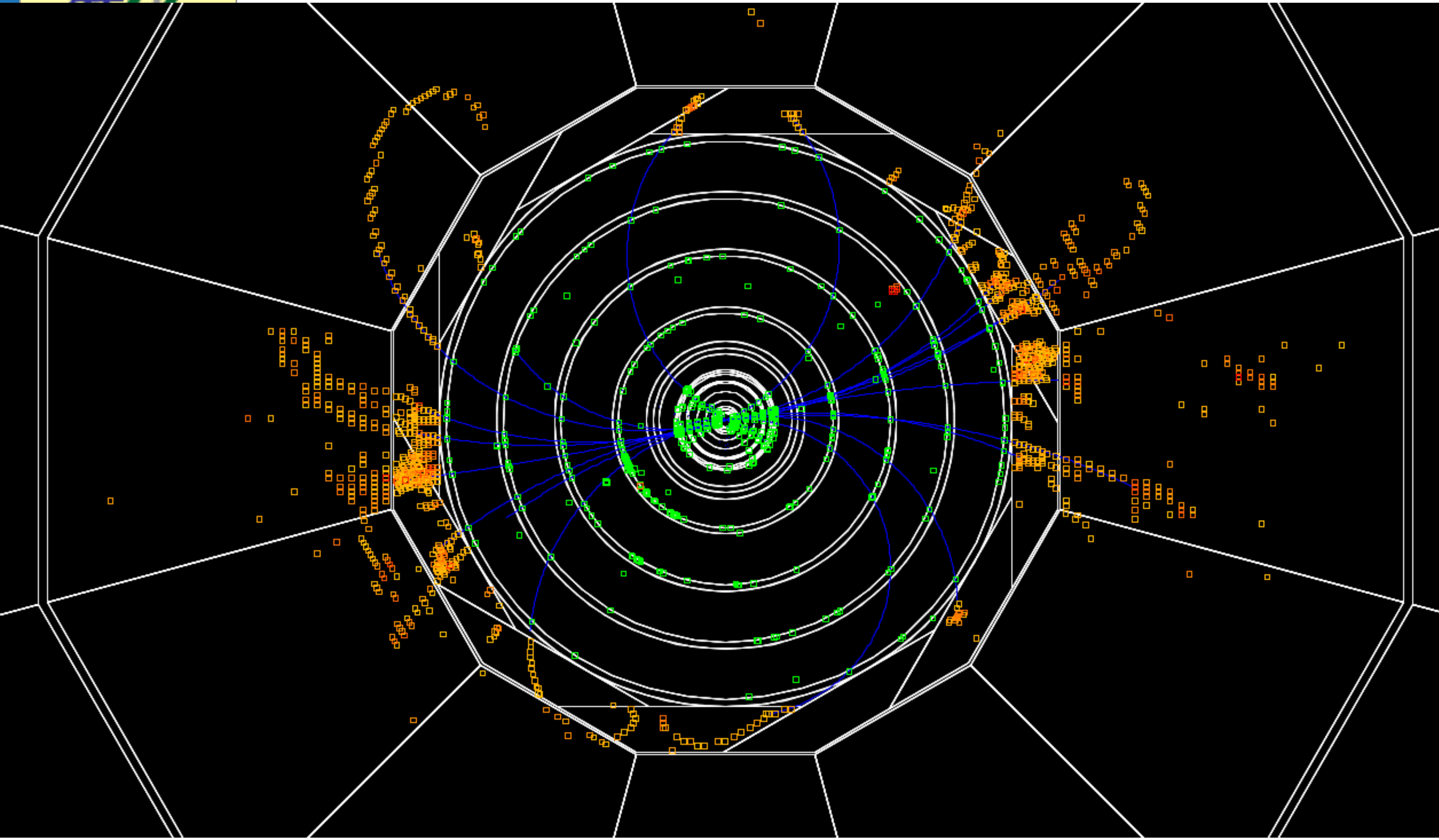


..	PDG ID	Type	Generator Status	Simulator Status	Parent
0	14	nu_mu	Final State	Left	23
1	11	e-	Other (0)	Created In Simulation,Stopped	2
2	-13	mu+	Final State	Left	23
3	-11	e+	Other (0)	Backscatter,Created In Simulation,Decayed In Calorimeter	5
4	2112	n	Other (0)	Backscatter,Created In Simulation,Decayed In Calorimeter	5
5	211	pi+	Other (0)	Created In Simulation,Decayed In Calorimeter	9
6	22	gamma	Other (0)	Created In Simulation,Decayed In Calorimeter	8
7	22	gamma	Other (0)	Created In Simulation,Decayed In Calorimeter	8
8	111	pi0	Other (0)	Created In Simulation,Decayed In Tracker	9
9	321	K+	Final State	Decayed In Tracker	16
10	-211	pi-	Final State	Decayed In Calorimeter	15
11	11	e-	Other (0)	Backscatter,Created In Simulation,Stopped	12
12	22	gamma	Final State	Decayed In Calorimeter	14
13	22	gamma	Final State	Decayed In Calorimeter	14
14	111	pi0	Intermediate		15
15	-213	rho-	Intermediate		16
16	-421	D0-bar	Intermediate		18
17	22	gamma	Final State	Decayed In Calorimeter	18
18	-423	D*0-bar	Intermediate		22
19	2112	n	Other (0)	Backscatter,Created In Simulation,Decayed In Calorimeter	21
20	2112	n	Other (0)	Backscatter,Created In Simulation,Decayed In Calorimeter	21
21	-211	pi-	Final State	Decayed In Calorimeter	22
22	-10413	unknown	Intermediate		23
23	511	B0	Intermediate		25
24	22	gamma	Final State	Decayed In Calorimeter	25
25	513	B*0	Intermediate		181
26	2112	n	Other (0)	Backscatter,Created In Simulation,Decayed In Calorimeter	27
27	211	pi+	Final State	Decayed In Calorimeter	31
28	22	gamma	Final State	Decayed In Calorimeter	30
29	22	gamma	Final State	Decayed In Calorimeter	30
30	111	pi0	Intermediate		31
31	213	rho+	Intermediate		181
32	22	gamma	Final State	Decayed In Calorimeter	41
33	2112	n	Other (0)	Backscatter,Created In Simulation,Decayed In Calorimeter	36
34	2112	n	Other (0)	Backscatter,Created In Simulation,Decayed In Calorimeter	36
35	2112	n	Other (0)	Backscatter,Created In Simulation,Decayed In Calorimeter	36
36	-211	pi-	Final State	Decayed In Calorimeter	40
37	2112	n	Other (0)	Backscatter,Created In Simulation,Decayed In Calorimeter	39
38	2112	n	Other (0)	Backscatter,Created In Simulation,Decayed In Calorimeter	39
39	211	pi+	Final State	Decayed In Calorimeter	40
40	113	rho0	Intermediate		41

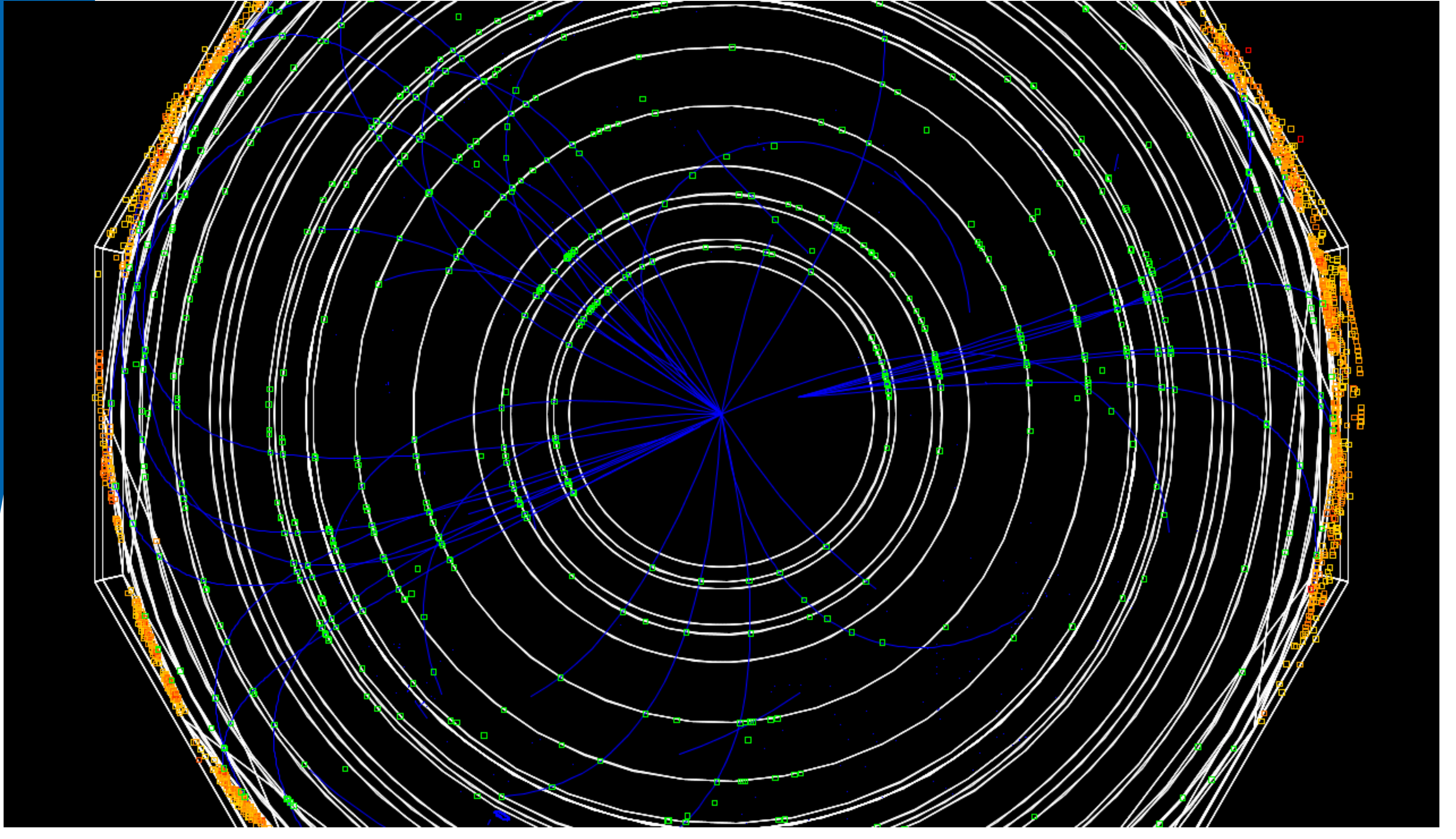
$H^0 \rightarrow \tau^+\tau^-$ event



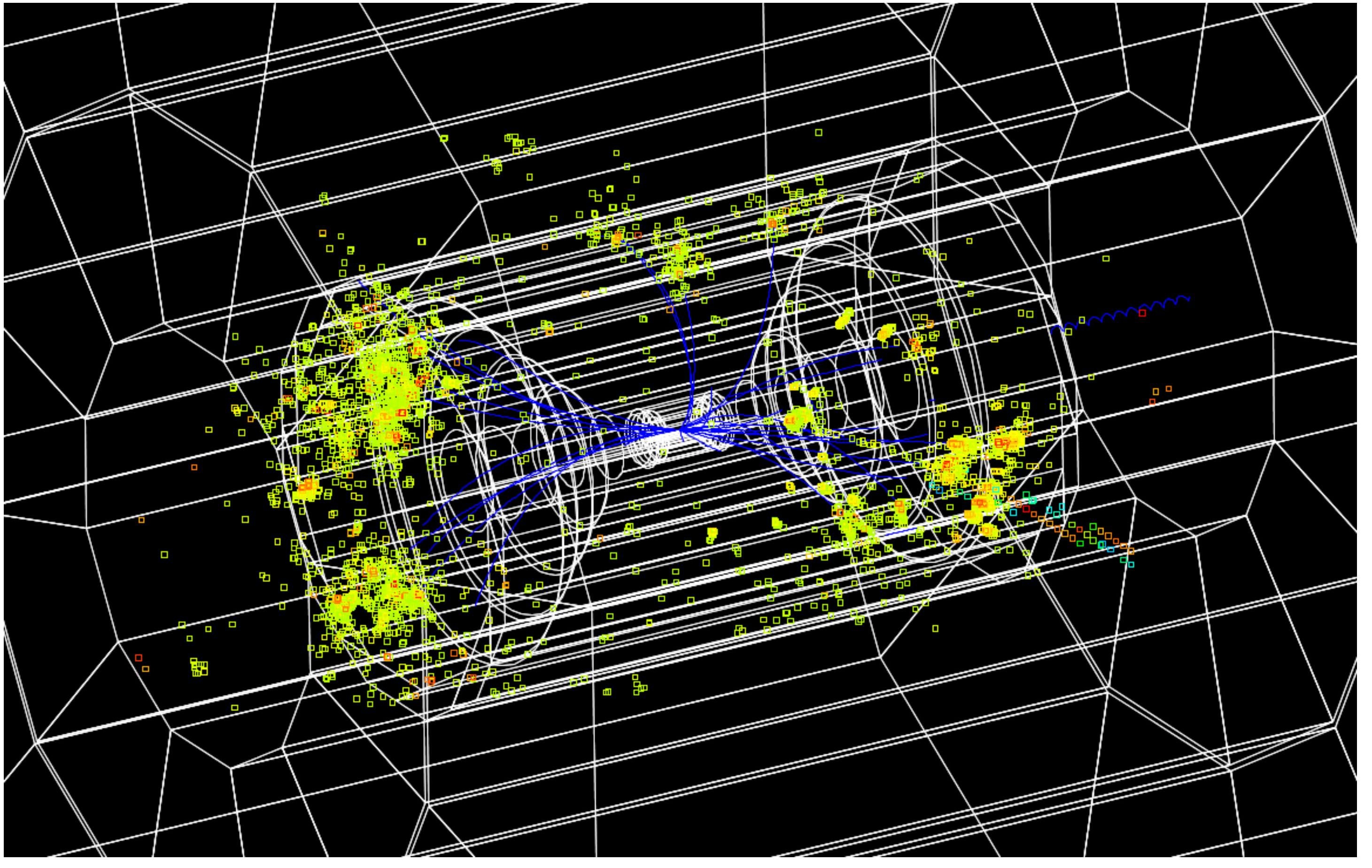
$H^0 \rightarrow bb$ event



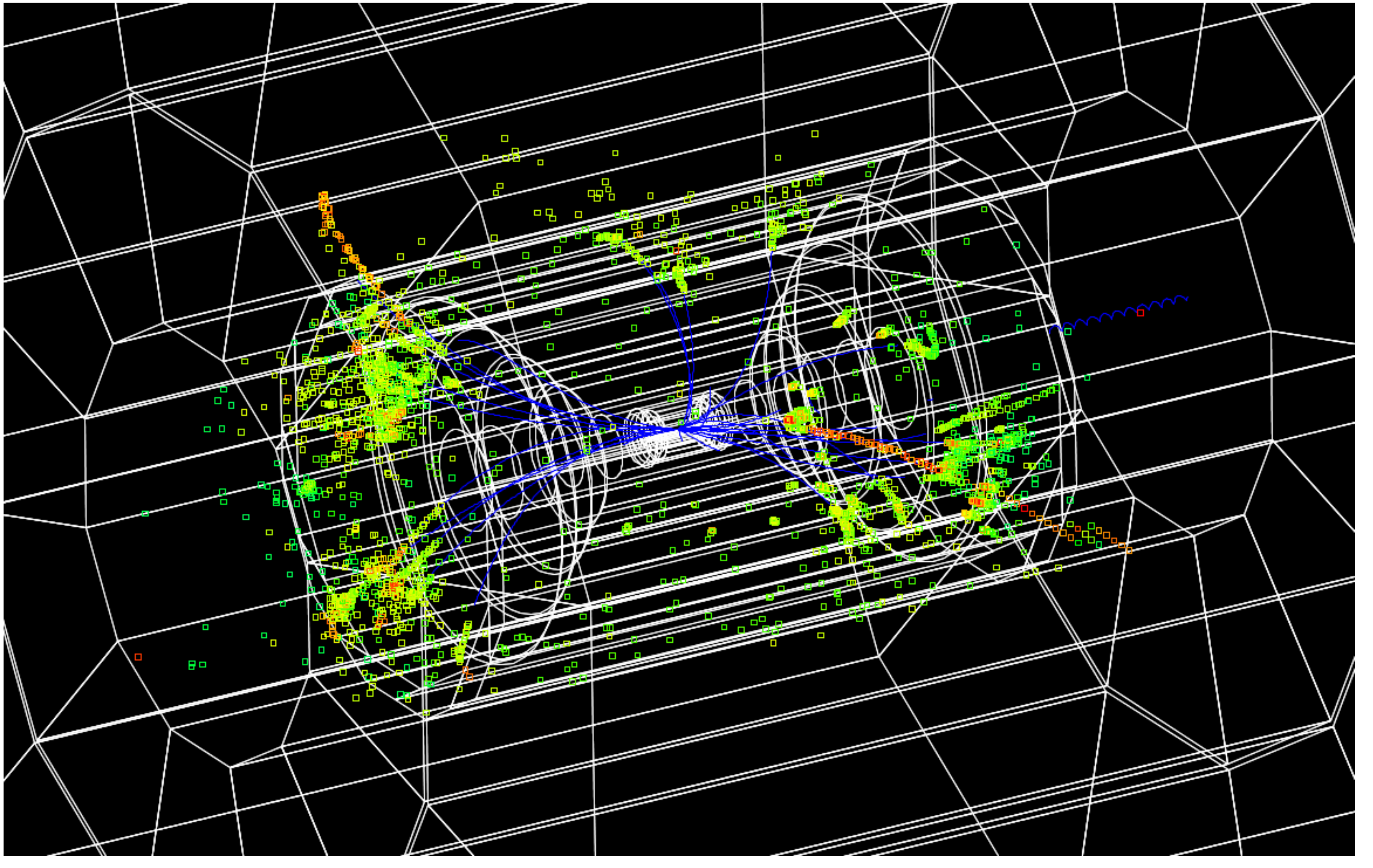
$H^0 \rightarrow$ bb event



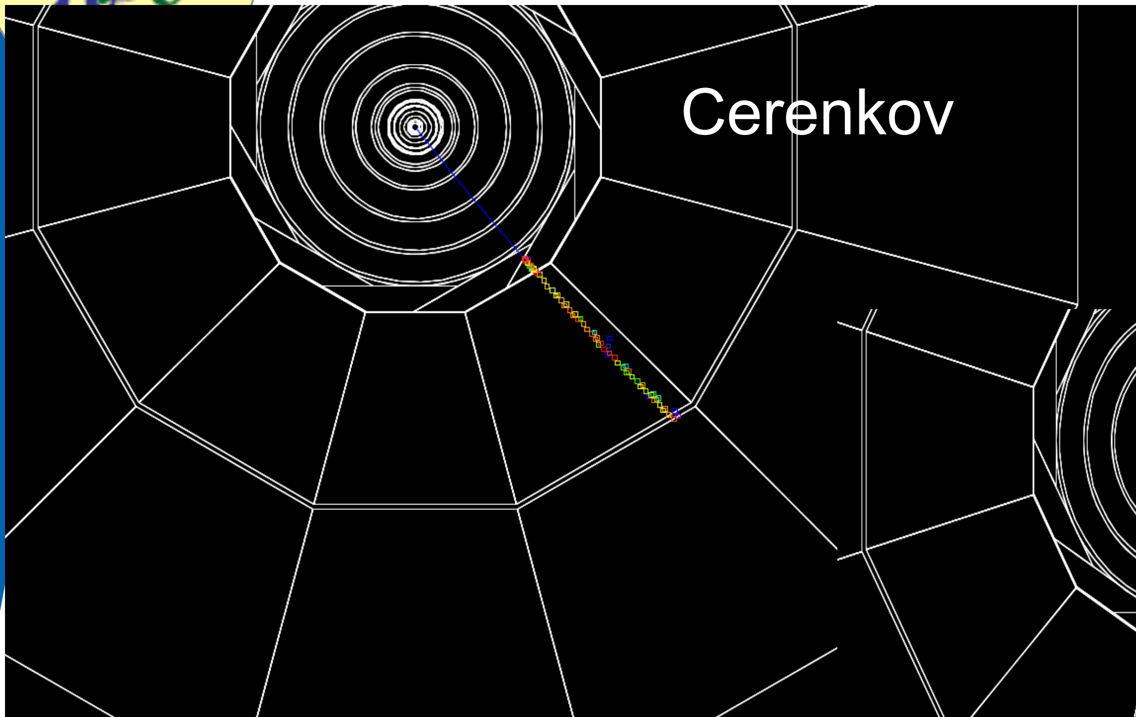
$H^0 \rightarrow$ bb event (Edep Hits)

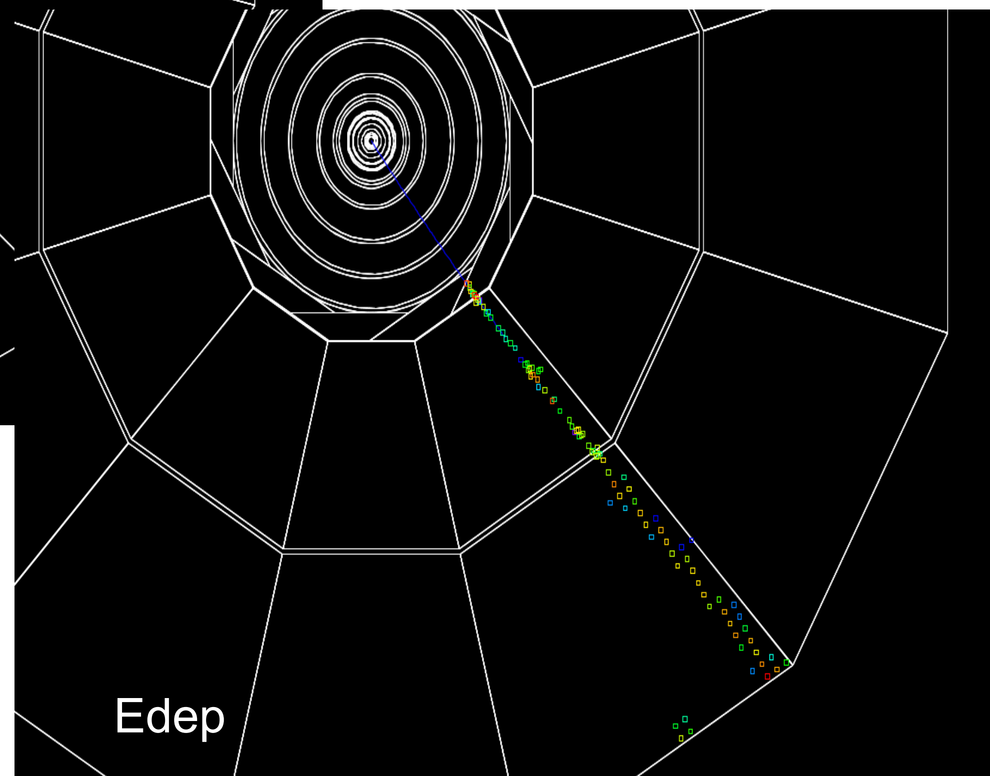


$H^0 \rightarrow$ bb event (cerenkov Hits)



Single Muon





Near term plan

- Check the detector description!
- Get simulation running on the Grid.
- Then generate single particle, Higgs, SM bgr. and machine bgr. once available.
- Find out how to modify and run: tracking, vertexing, jet reconstruction, b-tagging, PFA…
- Many fun studies where people can contribute, join the fun.